Condensation on and in windows

What was once right but now wrong? Food for thought

To avoid unnecessary heat loss, the requirements on air-tightness of modern buildings have increased. One undesired side-effect of this type of construction is the formation of condensation on and in the window frame. The Holzforschung (wood research) Austria wanted to review this from a neutral standpoint and bring to light the exact causes and suggest solutions.

Condensation in windows has become a greater problem in recent years.

In recent years, claims with regards to window condensation have increased dramatically and the Holzforschung Austria has recorded an accumulation of this problem. The trusted construction methods of the last decades do not seem to work any longer and window manufacturers are also seeing what seem to be unjustified claims from consumers against defective construction.

Causes

The causes for condensation are on the one hand the gradient of vapour pressure from warm to cold (diffusion) and on the other hand ventilation which transports moisture (convection). The inner moisture level (breathing, cooking etc.) causes a continuous replenishment. These physical incidents were obviously always the same, which asks the question why there

are increases in complaints and damage relating to condensation. The primary factors for this could be established as follows.

Building envelope

In earlier times, building envelopes generally had more leaks which guaranteed the evaporation of moisture. This resulted, however, in greater heat loss – the reason why today the "unwanted" natural ventilation has been almost totally eliminated. The greater gradient of vapour pressure means that even the slightest of leaks allows slow diffusion and convection of moisture into the window frame, even when the requirements on air-tightness are fulfilled. This moisture condenses in the rebate and can, in extreme cases, lead to ice formation.

Heating systems

Typically, radiators were placed under window openings. These created a constant stream of rising warm air, which counteracted the cooling and falling of air in front of the window. Today, more and more underfloor heating systems are being used, which with their minimal pre-heating temperatures have almost no effect on convection of warm air towards the windows.

Installation conditions

Even the smallest of leaks can in extreme cases cause ice formation.

The improved thermal properties of today's materials mean that windows are built deeper into their openings to be located in the insulating zone in order to reduce warm-bridging. This method of installation often means that

insufficient warm air reaches the window, even when conventional radiators are used below the openings. Closed window coverings function as usual.

Room climate

All of these points were close to the reason why in recent years increased problems with condensation on changed construction methods were apparent. The occupants' means of ventilation, however, had hardly changed to suit. Even when climate conditions are within standard levels, typical window constructions are often at their limits and it would be too simple to pass the blame to the frame-makers of occupants.
The following possibilities can help to react to the problem of condensation.

Occupant behaviour

Occupants are often blamed for their insufficient ventilation. Many times damage still occurs from condensation even though the occupant keeps the climate well within the range of living comfort. There is also the situation when the occupant is not in the room for extended periods to ventilate sufficiently, whereby ventilation doesn't appear to be the single solution.

Window construction

mould is one the most problematic consequences of condensation in windows.

An economical means of avoiding condensation in the rebate would be to use hidden fittings whereby the inner seal line could not be broken. Because this seal lies in the warmer room-side zone, the building physical performance of this seal is most critical and should not be

interrupted over its perimeter. These fittings are also relative to the weight of the sash and may be restricted as such. Middle and lip gaskets should have diffusion openings. To protect from surface condensation, windows with improved thermal performance should have already been considered in the initial design of the building. Whilst triple-glazed units with warm-edge spacers are quite normal in passive house construction, they are seldom used in conventional construction or even in low-energy buildings. Manufacturers are often questioned by customers what can be done to improve the limits of the construction.
An alternate measure to increase the surface temperature at the glass edge would be to increase the depth of the glass rebate whereby this raises concerns over structural performance of the remaining sash section and also potential for thermal breakage.

Ensuring primary ventilation

A further possibility to keep the problem under control, and also to guarantee hygienic room air quality would be to install controlled space-ventilation equipment with a heat-exchanger. Here there is a necessity to differentiate between central and local ventilation. Whilst the first might be more efficient but more costly to purchase and indeed install in an existing building; the second offers an interesting alternative: The cost of such equipment is about 1,000 Euro and it can be installed easily and as necessary in living rooms.

In conclusion it is important to note that the occupant should be made aware of the different conditions with respect to the air-tightness of the building envelope. In addition, it would be desirable to use triple-glazing with thermally improved spacer bars as standard. A regulated air change using a controlled

ventilation mechanism is also recommended not just to restrict condensation but also to maintain primary ventilation and thereby air hygiene.

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